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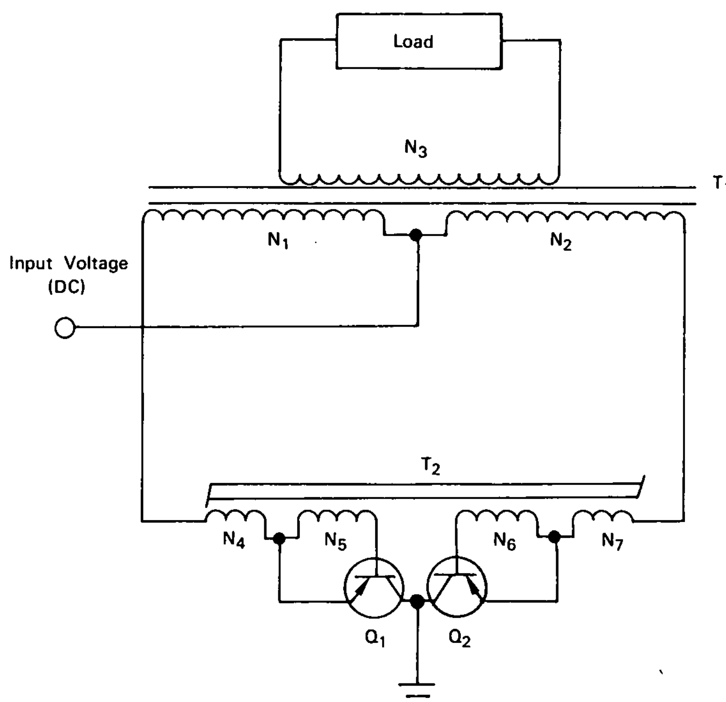
DC to AC Converter Operates Efficiently at Low Input Voltages



The problem: Designing an efficient dc to ac converter for low input voltages (0.5 to 4.0 volts). Recently developed electrical power sources (fuel cells, thermionic diodes, thermoelectric generators, and solar cells) produce high-current, low-voltage dc outputs which must be converted to ac for many applications. Since the output voltages from these power sources are very low, the converter used must be extremely efficient. Performance reliability is decreased when a large number of power sources are connected in series to increase the net output voltage to a sufficiently high level for operation with a less efficient converter.

The solution: A self-oscillating dc to ac converter which uses transistor switching to produce a square-wave output. The efficiency of the circuit approaches the maximum efficiency of the transistor switches.

How it's done: The converter consists of two switching transistors Q_1 and Q_2, output transformer T_1, and a saturable core transformer T_2. When a dc input voltage is applied to the circuit, one of the transistors, e.g., Q_1, starts to conduct. The emitter-to-base-voltage drop in transistor Q_1 appears across winding N_5 of transformer T_2 and establishes the direction of flux change in the core of T_2. When T_2 becomes saturated, decoupling occurs between N_4 and N_5. The base

(continued overleaf)

current to Q_1 decreases and Q_1 is turned off. Energy stored in T_2 is returned to the circuit and Q_2 is turned on. As T_2 cyclically saturates and desaturates, the input voltage is impressed first across N_1 and then across N_2, thereby inducing an alternating square wave in the output winding N_3 connected to the load.

Notes:

1. This converter is also suitable for use with higher-voltage power sources.
2. Tests have shown that the converter has a high efficiency throughout a wide range of loads. For a 20-ampere dc input, the efficiency increased from 79% at a 1-volt input to 94% at a 3-volt input.
3. The converter is able to withstand relatively large overloads for short time intervals without transistor damage.
4. The transistors should be reasonably well matched. To compensate for the effects of temperature on transistors with dissimilar characteristics, they should be mounted in close proximity on a common heat sink. A high degree of mismatch between the emitter-base voltage drops of the two transistors can be compensated by adjusting the relative number of turns in windings N_5 and N_6.
5. Inquiries concerning this invention may be directed to:

   Technology Utilization Officer
   Goddard Space Flight Center
   Greenbelt, Maryland, 20771
   Reference: B65-10178

Patent status: NASA encourages the immediate commercial use of this invention. It is owned by NASA and inquiries about obtaining royalty-free rights for its commercial use may be made to NASA, Code AGP, Washington, D.C., 20546.

Source: Duke University under contract to
Goddard Space Flight Center
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